1. The piston, which is shown in the figure, moves to the right at a velocity of $V_P = 1$ m/s, while the cylinder moves to the left at a velocity of $V_C = 0.5$ m/s. Determine the volumetric flow rate, $Q$.

(Ans: $-0.09425$ m$^3$/s)

2. Water flows through a 90° elbow, as shown in the Figure. Assuming frictionless flow and neglecting the effect of gravity, determine the horizontal and vertical components of the resultant force acting on the elbow. The density of water is 1000 kg/m$^3$.

(Ans: -5000 N, 6250 N)

3. When immersed in a uniform stream, a thick elliptical cylinder creates a broad downstream wake, as idealized in Figure. The pressures at the upstream and downstream sections are approximately equal, and the fluid is water at 20°C. If $U_0 = 4$ m/s and $L = 80$ cm, estimate the drag force on the cylinder per unit width into the paper. Also compute the dimensionless drag coefficient $C_D = 2F/(\rho U_0^2 bL)$.

(Ans: 4260 N, 2/3)
4. The boat in Figure is jet-propelled by a pump which develops a volume flow rate $Q$ and ejects water out the stern at velocity $V_j$. If the boat drag force is $F = kV^2$, where $k$ is a constant, develop a formula for the steady forward speed $V$ of the boat. 

(Ass: $V = \sqrt{\frac{QV_j}{k}}$)

5. A static thrust stand as sketched in Figure is to be designed for testing a jet engine. The following conditions are known for a typical test: Intake air velocity= 200 m/s; exhaust gas velocity=500 m/s; intake cross-sectional = 1 m$^2$; intake static pressure=22.5 kPa=78.5 kPa (abs); intake static temperature = 268 K; exhaust static pressure =0 kPa=101 kPa (abs). Estimate the nominal thrust for which to design. Assume air is ideal gas. (Ass: 83700 N)
6. A large irrigation sprinkler unit, which is mounted on a cart, discharges water at a velocity of 30 m/s through a nozzle with an exit diameter of 0.04 m. The nozzle is inclined by $30^\circ$ to the horizontal, as shown in the figure. Determine the moment about the origin, which tends to overturn the cart. The density of water is 1000 kg/m$^3$. (Ans: $\vec{T}_{\text{cart}} = 1393\hat{k}$ Nm)